

CONTRIBUTIONS TO THE ANATOMY OF THE INDIAN ELEPHANT (*ELEPHAS INDICUS*). PART III. THE HEAD<sup>1</sup>. By M. WATSON, M.D., *Demonstrator of Anatomy in the University of Edinburgh.*

I HAVE no intention in this communication of writing a full description of the anatomy of the head of the Indian Elephant, but merely to direct attention to certain structures which have either been overlooked by previous anatomists, or have been described as possessing arrangements differing from those which I have met with in the course of my dissection.

TEMPORAL VENOUS RETE MIRABILE.

In *Froriep's Notizen*, October, 1832, p. 39, the following passage occurs:—Otto “showed a drawing of a peculiar *arterial* network, which he found in the neighbourhood of the peculiar excretory gland of the head of the elephant, situated between the eye and the ear, and seemingly occupying the entire side of the head, and remarked that similar arterial retia and anastomoses were to be found in several tardigrades, as well as in the extremities of many plantigrades.” The same author, in his *Erläuterungs-Tafeln* (Heft 6), gives a figure of this rete, but in the explanation appended to the plate does not state whether the rete is venous or arterial. As, however, the figure is coloured *red*, we must conclude that he believed it to be an *arterial* network, as in all the other figures blue is the colour used to distinguish the veins when present. Farther, Mayer in his paper (*Nova Acta* XXII.) refers to this description; and although he had himself dissected the animal, does not disagree with it. In my own dissection I found, by means of injection, that this rete was not arterial but *venous*. It is formed by numerous anastomosing veins, which occupy the whole of the temporal fossa, lying superficial to the temporal muscle, but on

<sup>1</sup> Part I. On the Thoracic Viscera, appeared in this *Journal*, November, 1871; Part II. On the Urinary and Generative Organs, in November, 1872. This part was read as a communication at the Bradford meeting of the British Association, Sept. 22, 1873.

a plane deeper than that of the temporal arteries, or that of the peculiar temporal gland. These veins are small in size round the margins of the temporal fossa, and are formed by the junction of numerous rootlets derived from the skin and superficial structures. Increasing in size as they are traced down to the temporal fossa, and communicating freely with one another to form the rete, they finally converge toward the root of the zygoma to form three or four main trunks, which uniting together give rise to the temporal vein. By means of several branches a communication is opened up with the facial vein in front, but this latter trunk takes no part in the formation of the rete, which moreover receives several branches from the substance of the temporal gland. It is worthy of remark that there are no valves present in the veins forming this rete, as the entire network can be freely injected from the trunk of the temporal vein. This trunk finally unites with that of the internal maxillary vein, and both open into that of the internal jugular, the external jugular vein being absent in the elephant.

The temporal artery, after crossing the zygoma, divides into two main trunks, from both of which numerous branches are given off to the surrounding parts, but they have no tendency to form a rete, as described by the authors before referred to. What may be the function of a venous rete in this situation it is difficult to determine.

### EYE.

In the next place I wish to draw attention to some interesting points relating to the arrangements of parts within the orbit of the elephant. First, as regards the muscles of the orbit, Mayer (*Nova Acta*) states that there is a depressor of the lower eyelid in this animal, in addition to the other muscles usually contained within the orbit. So far as I can ascertain, he is the only author who has, up to this time, observed the muscle in question. It arises along with the recti and obliqui from the bony canal posterior to the orbit, passing forward beneath the globe of the eye in the same manner as the elevator of the upper lid passes forward above the eye, and is inserted into the cartilage of the lower eyelid. It evidently

depresses the lower eyelid. In addition to this muscle there is farther to be observed a very extensive and well developed periosteal muscle, which has not hitherto been observed in this animal. It corresponds exactly in position to the similar muscle in the sheep and deer<sup>1</sup>. The orbit itself is completed posteriorly and inferiorly by periosteum, and it is in relation with the orbital surface of this periosteum that the muscle referred to is situated. The fibres composing it, which are of the involuntary or non-striated description, form a large sheet covering nearly the whole of the periosteum, and run from without obliquely forward and inward. The function of this muscle, although generally stated to be that of a protractor of the eyeball, is, I think, difficult to determine with precision. Camper, Harrison, and Mayer, refer to two small but distinct muscles, which pass to be inserted into the cartilage of the third eyelid. Of these, one arises from the lower, and the other from the upper eyelid, and both pass inwards to be inserted into the cartilage just referred to. On careful dissection I have not found them to be distinct muscles, but formed by certain of the palpebral fibres of the orbicularis palpebrarum, which pass inward to be inserted into the third eyelid. According to Mayer, one of these muscles acts by drawing the third eyelid outwards across the globe of the eye, whilst the other retracts it toward the inner canthus. That this is the action of these muscles seems to me extremely doubtful, as both being formed of prolongations of the orbicularis, it is difficult to imagine that two parts of the same muscle supplied by one nerve (the 7th) should have actions so opposed to one another. So far as a study of the anatomical arrangement of the parts would enable me to decide, I am inclined to think that *both* those muscles will tend by their contraction to draw the third eyelid outwards across the eye, but by what agency this lid again regains its position is more difficult to determine. It would be interesting to learn from those who may have opportunities of watching the elephant during life, whether the third eyelid is drawn across the eye when the upper and lower eyelids are separated, or

<sup>1</sup> See Professor Turner's papers on the Periosteal Muscle of the Orbit in Man, the Sheep and Deer, in *Proc. Roy. Physical Soc. of Edinburgh*, Dec. 19, 1861, and *Natural History Review*, Jan. 1862.

only when these are closed. If the latter supposition be correct, it will establish the views I have advanced regarding the action of these little muscles.

Regarding now the lachrymal apparatus of the elephant, we find that various statements have been made by different authors. Camper and Harrison, on the one side, maintain that no portion of a lachrymal apparatus is present in the elephant, while, on the other hand, Mayer (the most recent writer on the subject) says, "The puncta lachrymalia are small, the lachrymal duct single and very narrow, the lachrymal gland of tolerable size. Its excretory duct is as large as a knitting needle, and opens on the external angle of the eyelids;" and he adds, "It is striking that Camper should neither have discovered this gland, its excretory duct, nor the lachrymal canal." Perrault also mentions the presence of lachrymal glands in the elephant. My own observations agree with those of the authors who have not discovered any portion of a lachrymal apparatus, although each separate element was carefully looked for. It is difficult to explain the statements of those authors who maintain the existence of such an apparatus, more especially when it is borne in mind that the ethmoid bone in the elephant is quite imperforate, and consequently affords no way of escape for the lachrymal secretion. True, a Harderian gland, similar to that which exists in connection with the third eyelid in birds, is to be found in the elephant. It does not, however, occupy the usual position of the lachrymal gland at the outer angle of the orbit, but rests between the inner wall of that cavity and the internal rectus muscle. Its excretory duct, moreover, opens on the surface of the third eyelid, and not in the usual position of the ducts of the lachrymal gland. That this gland to some extent fulfils the function of the lachrymal gland is rendered probable by the statements of African travellers, one of whom (Cumming) describes an elephant, after suffering from the effect of several balls, as weeping profusely. The mode, however, in which the secretion of this gland is got rid of, under ordinary circumstances, is difficult to determine in the absence of all trace of an excretory apparatus.

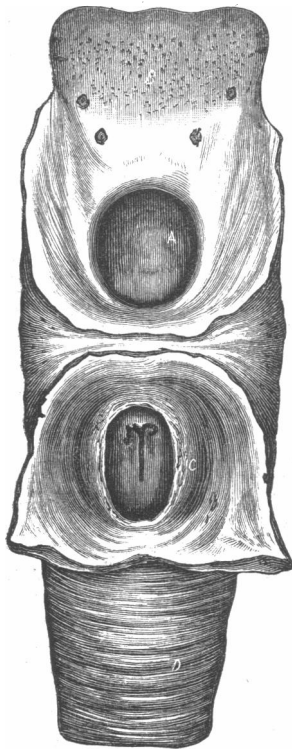
## THROAT.

I shall now direct attention briefly to certain peculiarities in the formation of the throat of the elephant, which up to this time have escaped notice, and which seem to be of importance, inasmuch as they afford an explanation of some of the creature's functions which have not hitherto been explained. In my first communication I had occasion, when remarking on certain peculiarities in the thoracic viscera of the elephant, to refer to the following statement made by Sir Emerson Tennent in his work on Ceylon, to prove that the animal possesses the power of withdrawing water stored within the cavities of the stomach by means of the trunk inserted into the mouth. Sir E. Tennent says, with reference to the Indian elephant, "I have elsewhere described the occurrence to which I was myself a witness of elephants inserting their probosces into their mouths and withdrawing gallons of water, which could only have been contained in the receptacle figured by Camper and Home;" and he (Tennent) farther quotes from the author of the *Ayeen Akberry* as follows: "An elephant frequently with his trunk takes water from his stomach and sprinkles himself with it, and it is not in the least offensive."

That the same thing is true as regards the African elephant has been observed by Cumming, who, in his travels in South Africa, when speaking of these animals, says: "They seemed heated by the pace at which they had retreated, and were now refreshing themselves with large volumes of water which Nature enables them to discharge from their capacious stomachs and shower back upon their bodies with their extraordinary trunks." This regurgitation of water from the stomach I showed in my first paper to depend not on any peculiarity of structure in the elephant as compared with that of other animals, but that it was a function similar to the physiological regurgitation of food in the ruminant, and performed by means of the combined actions of the diaphragm and other abdominal muscles. It now remains to show in what the peculiarity of construction of the throat of the elephant consists to enable the trunk when placed in the mouth to withdraw the water regurgitated from the stomach. For it is evident that were the throat of this animal

similar to that of other mammals, this could not be accomplished, as the insertion of a body, such as the trunk, so far into the pharynx as to enable the constrictor muscles of that organ to grasp it, would at once give rise to a paroxysm of coughing, or were the trunk merely inserted into the mouth, it would be requisite that this cavity be kept constantly filled with water at the same time that the lips closely encircled the inserted trunk. The formation of the mouth of the elephant, however, is such as to prevent the trunk ever being grasped by the lips so as effectually to stop the entrance of air into the cavity, and thus at once, if I may so express it, the pump-action of the trunk is completely paralysed. We find therefore that it is to some

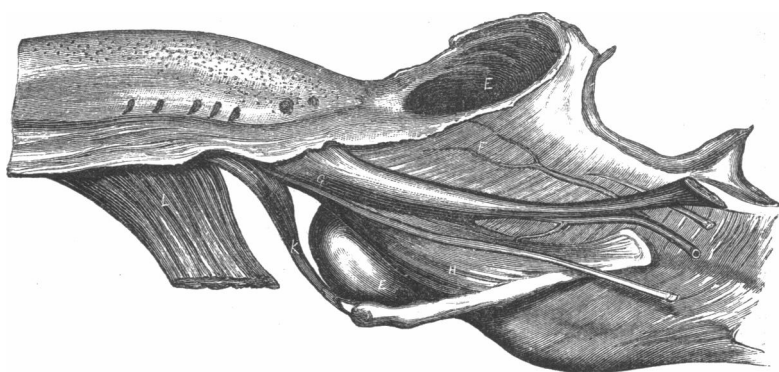
Fig. 1.



Explanation to Figure 1. A, superior aperture of pharynx. B, root of tongue. C, soft palate with larynx projecting through the centre. D, pharynx.

modification of the throat that we must look for an explanation of the function in question, and this we find to be as follows:—The superior aperture of the pharynx, Fig. 1 A, is extremely narrow, so much so as to admit, with difficulty, of the passage of the closed fist. Immediately posterior to this narrow aperture the pharynx dilates into a pouch of large size, Fig. 2 E, capable of containing a considerable quantity of fluid. This pouch is prolonged forward beneath the root of the tongue, and is bounded in the following manner. The floor extends from the epiglottis as far forward as the root of the tongue, being formed from behind forward by the thyroid cartilage, thyro-hyoid membrane, and hyoid bone. Its lateral walls are completed by the sides of the pharynx (that is, by the superior constrictor muscles, Fig. 2 F), in addition to the stylo- G, and hyo-glossi H, muscles. The root of the tongue forms the anterior boundary, whilst the posterior wall is completed by depression of the soft palate, or when the latter is elevated the pouch then communicates freely with the œsophagus. In connection with this pouch is to be observed the very peculiar form of the hyoid bone, which being deeply concave on its upper surface forms as it were the greater part of the floor of this pouch. Between the pouch and the concavity of the hyoid bone, moreover, there is placed a large quantity of loose and distensible connective tissue, which permits of the expan-

Fig. 2.



Explanation to Figure 2. E, E pharyngeal pouch. F, superior constrictor. G, stylo-glossus. H, hyo-glossus. K, small muscle which diminishes the depth of the pharyngeal pouch. L, genio-glossus muscle.

sion of the pouch. The size of the latter is, moreover, liable to alteration by the actions of several muscles. These are more especially the hyo-glossi muscles, and two little additional muscles, Fig. 2 K, the homologies of which I have not yet been able to determine, which, springing from the middle line of the hyoid bone in front of the pouch, pass up, one on either side of the middle line, and blend with the other muscles forming the root of the tongue. By the action of these muscles the pouch may be diminished in *depth*; but in consequence of the narrow interval existing between the hyoid cornua, the *length* of the pouch from before backwards cannot be altered, as the thyroid-cartilage is thereby prevented from being approximated to the hyoid bone. I have now to complete the anatomical description of this pharyngeal pouch by a reference to the formation of the soft palate. This, Fig. 1 C, which is of very large size, forms almost a complete muscular diaphragm, through the central aperture of which projects the superior extremity of the larynx, which thus in some respects approximates to the arrangement of the corresponding parts in certain cetacea as described by Dr James Murie<sup>1</sup>. With reference to the muscles entering into its formation, we find that the palato-glossus is entirely absent, its place being supplied by a wide and extremely distensible fold of mucous membrane. The palato-pharyngeus, on the other hand, is of large size, and forms, in fact, the principal feature in the soft palate. There is neither a levator nor a tensor palati present. Such being a brief description of the anatomical arrangements met with in connection with this pharyngeal pouch, a few words may now be said on their physiological bearing. An elephant can, as the quotations sufficiently prove, withdraw water from his stomach in two ways; first, it may be regurgitated directly into the nasal passages by the action of the diaphragm and abdominal muscles, the soft palate being at the same time depressed so as to prevent the entrance of water into the mouth. Having, in this manner, filled the large nasal passages, communicating with the trunk, the water contained in them is then forced through the trunk by means of a powerful expiration; or, in the second place, the water may be withdrawn from the cavity of the

<sup>1</sup> *Trans. Zoolog. Soc. Lond.* Vol. VIII.

mouth by means of the trunk inserted into it. Now, in this case, it is manifestly impossible that the water can be contained within the cavity of the mouth itself, as I have already shown that the lips in the elephant are so formed as effectually to prevent this. The water regurgitated is, however, by means of the elevation of the soft palate, forced into the pharyngeal pouch. The superior aperture of this pouch being much narrower than the diameter of the pouch itself, and being completely surrounded by the muscular fibres of the stylo-glossus on each side and the root of the tongue in front, which is prolonged backwards so as to form a free sharp margin, we have thus as it were a narrow aperture surrounded by a sphincter muscle, into which the trunk being inserted and grasped above its dilated extremity by the sphincter arrangement just referred to, air is thus effectually excluded, and the nasal passages being then exhausted by the act of inspiration, water is lodged within these passages to be used as the animal thinks fit, either by throwing over his body or again returning it into his mouth, as observed on one occasion by Cumming, who says: "Throughout the chase this elephant repeatedly cooled his person with large quantities of water, which he ejected from his trunk, over his back and sides; and just as the pangs of death came over him, he kept pouring water into his bloody mouth until he died." The increase in the size of this pouch is accomplished mainly by the depressor muscles of the hyoid bone, which, in consequence of the tongue being fixed and restrained in its movements by the muscles attaching it to the lower jaw, depress the hyoid bone and thyroid cartilage, which are both freely moveable, at the same time that the tongue itself is almost fixed, and in this manner the depth of the pouch is materially increased. Such is the explanation of a function which, so far as I am aware, has not up to the present time been satisfactorily explained, and it will be of much interest to examine the corresponding region in the African elephant, to ascertain if arrangements similar to those I have described in the Indian species are to be found in that animal. If similarity of function implies similarity of structure, then I have little doubt that such will prove to be the case. The modifications in the throat of the elephant are not without interest from two points of view.

In the first place, these modifications are such as show that, in respect of this portion of its structure as in several others, the elephant closely resembles certain forms of the cetacea, and are thus of importance inasmuch as they furnish one more item of evidence in favour of a relationship which has been long suspected to exist between those two groups, which when taken by themselves, although they seem sufficiently widely separated, are, nevertheless, connected by a number of intermediate forms: and, secondly, they are not without interest inasmuch as they afford food for reflection as to the origin of these modifications when compared with the corresponding parts of other mammals. Did they arise gradually in accordance with the law which tends ever to bring the organism into harmony with external conditions, and so to adapt the functions of such an organism as finally to give rise to that chain of circumstances which is formulated in the expression, "survival of the fittest"? Or are we to believe, with the teleologists of the previous century, that these modifications were occasioned by the direct intervention of a great First Cause ever attempting to remedy imperfections which he had at first created? Which of those alternatives is to be accepted must be left to the private judgment of each individual enquirer.